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A multi-dimensional Operations Research Approach to investigate future technology innovation, integration and vulnerabilities

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Overview

- Aim of the Study is to support Future Land Warfare Branch of Army HQ in studies of the effects and implications of future technologies
- Our inputs and tools are:
  - Army as a System (AAAS) descriptors of warfare
    - 7 core skills/capabilities
  - Agent Based Distillations (ABD)
    - to explore behaviours
  - Field Anomaly Relaxation (FAR) to identify inconsistencies
  - Historical analysis to identify success factors

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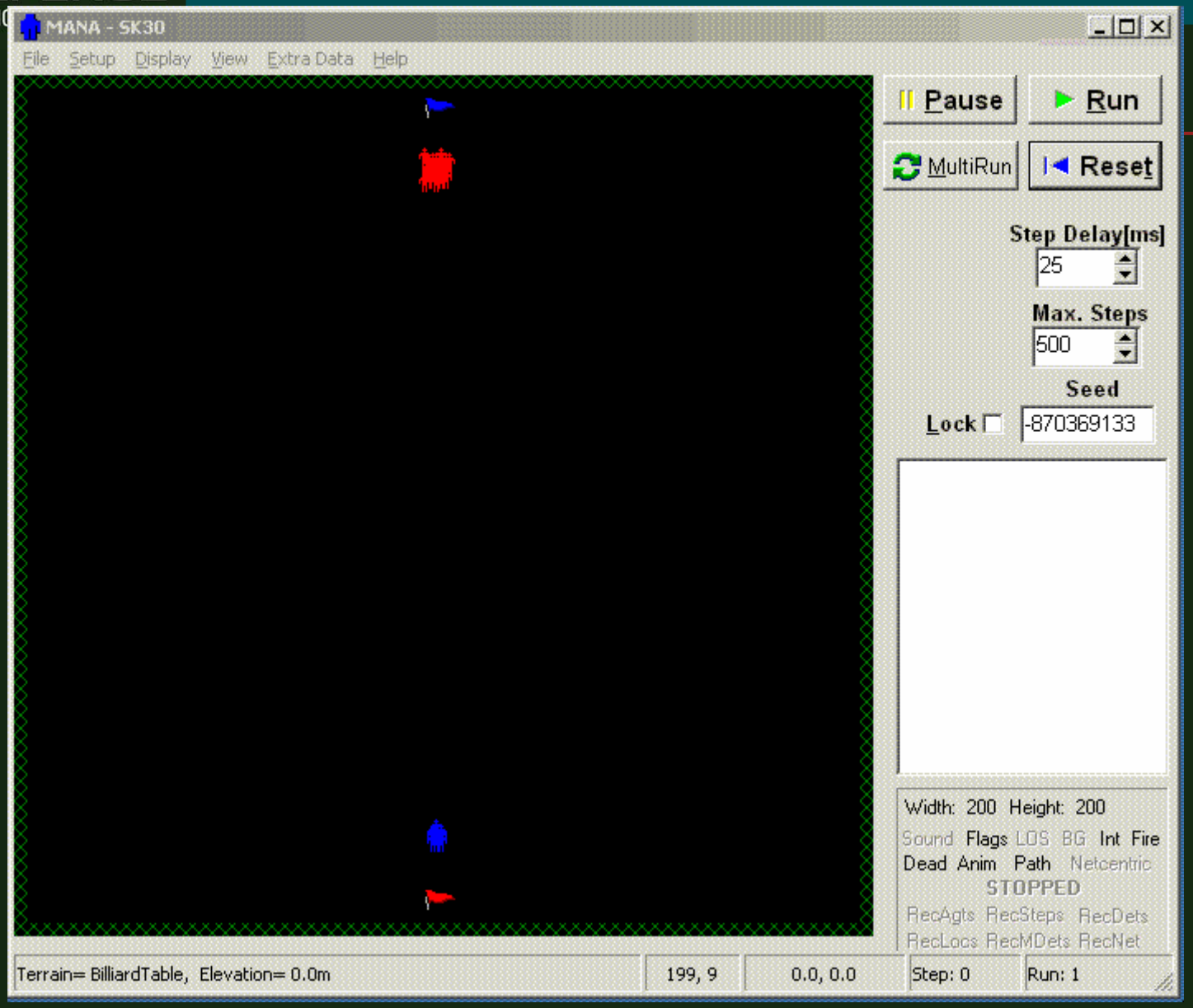
Army as a System Descriptors

- A conceptual approach to describing Land Force activity
  - Engagement
  - Information collection
  - Communication
  - Protection
  - Movement
  - Sustainment
  - Decision-making

Agent-Based Distillations

- Low-resolution constructive simulations
- Use agent techniques to model behaviour rather than physics
- Use personality vectors and probabilistic rules to control behaviour
- Aims to show emergent behaviour for conceptual insight rather than realism for prediction

- We have used MANA, developed by Stephen, Anderson and Lauren from New Zealand's Defence Technology Agency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The Field Anomaly Relaxation (FAR) Approach

- Uses Rhyne's FAR methodology as a means of manipulating data (not for futures projection)
- Use the AAAS descriptors as sectors
- Classify levels - Eg engagement (E) E_1 (poor) - E_4 (good)
- The skills are not independent
  - can you have E_4 and P_4? ie perfect weapons against perfect protection - an anomaly
  - assisters - a high value in a field enhances value in another
- Resources or other constraints, additional to FAR calculations, will lead to other reasons why you can't have a perfect $E_4I_4S_4C_4P_4M_4D_4$

The FAR approach (2)

- How many combinations?
  - If 3 levels then 3^7 possibilities
    - = 2187
  - If 4 levels - 4^7 possibilities
    - = 16384
- FAR allows us to eliminate many of these possibilities
- Goal is to use FAR to develop plausible combinations of core skills
  - These could be potential concepts ie put words around a combination eg $E_4I_3S_2C_3P_2M_4D_2$ = first in light strike force

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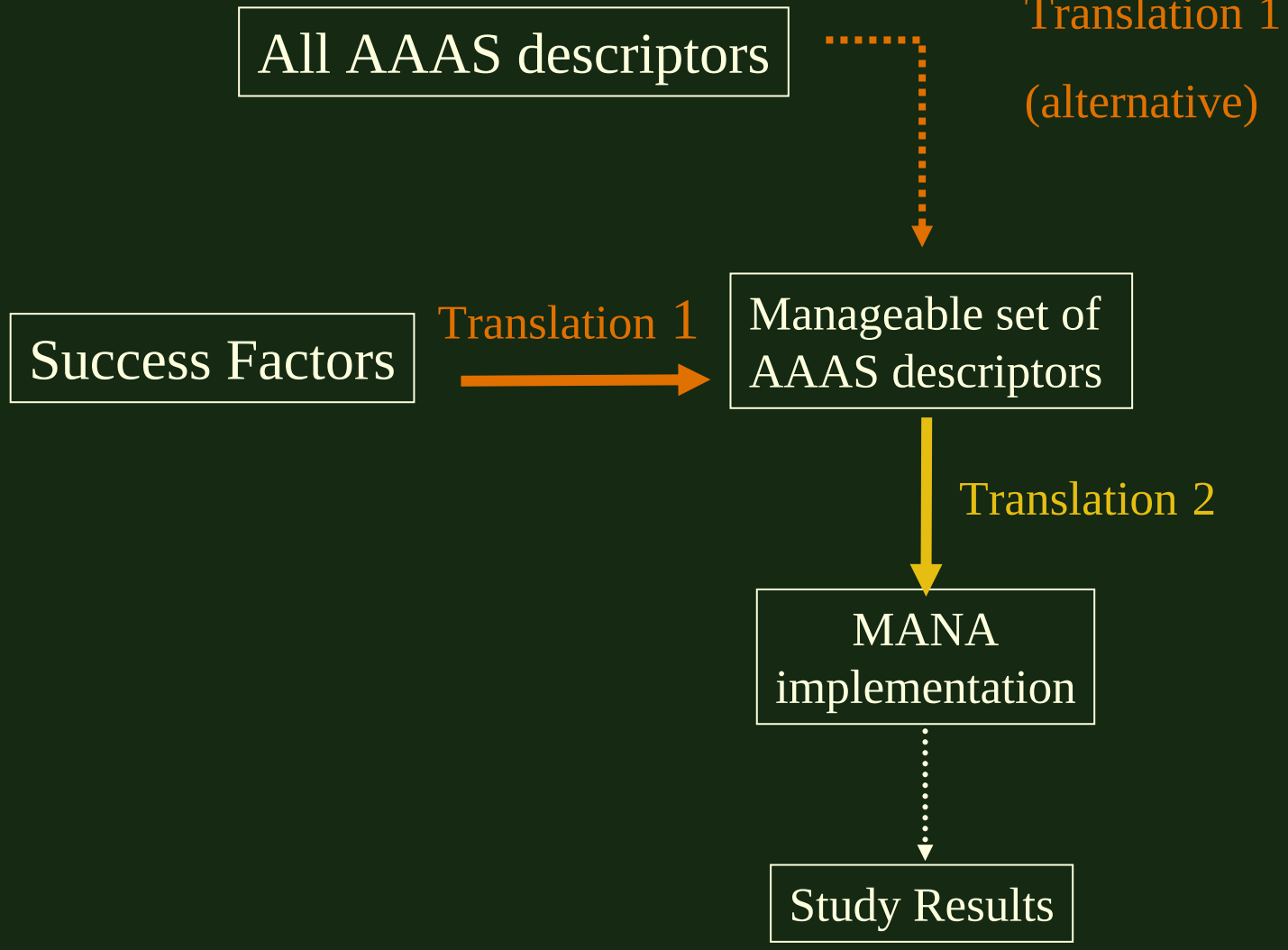
The Historical Analysis Approach - Success Factors

Based on quantitative analysis, you must have these to achieve success, or to avoid failure:

1. Surprise
2. Shock
3. Aggressive Reconnaissance
4. Air Superiority
5. Intelligence
6. Logistics
7. Command, Control and Communication (C^3)
8. Mobility
9. Special Forces
10. Attack Reserves
11. Commanders Intention
12. Defence Frontage
13. Defence Effectiveness
14. Attack Boldness

Adapted from Speight, Rowland and Keys, MOR, 1997

Approach taken in our studies



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Translation 1 - Success factors to AAAS descriptors

Expert opinion gives us the translation in terms of the effect on the "differential" between blue and red

	E	I	C	P	M	S	D
Surprise							
Shock							

Where darker is larger contribution

Engagement Information collection Communication Protection
Movement Sustainment Decision-making

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Rationales for success factor translations - surprise

- When surprised, it takes some time to re-orientate.
  - Blue force is prepared and everything is in place with clear purpose
  - When shot at, the sensor range and movement speed of red force are degraded.

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Rationales for success factor translations - shock

- Shock is evident when the adversary is able to react to an attack but does not.
  - Blue has overwhelming directed firepower and clear purpose
  - When the enemy section is shot at, their sensor range and firing range are degraded, and the degraded values remain in place for a certain duration (varied through the experiment).

Translation 1 - Success factors to AAAS descriptors 2

So if we start from a "neutral" state of $E_2I_2S_2C_2P_2M_2D_2$, then we can propose indicative new states

	New blue state	New red state
surprise	$E_2I_{2.5}S_2C_3P_2M_{2.5}D_3$	$E_2I_{1.5}S_2C_1P_2M_{1.5}D_1$
	Large gain for C and D lesser for I and M	Large loss for C and D lesser for I and M
shock	$E_3I_{2.5}S_2C_2P_2M_{2.5}D_3$	$E_1I_{1.5}S_2C_2P_2M_{1.5}D_1$
	Large gain for E and D lesser for I and M	Large loss for E and D lesser for I and M

Engagement Information collection Communication Protection Movement Sustainment Decision-making

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Translation 2 - AAAS descriptor to MANA factor

		Movement speed	Sensor range	Firing Range	Duration of state
Surprise	Initial value	200	50	15	
	"Shot at" State	0, 5, 10, 50, 100, 500	11-16, 20, 30, 40 , 50	15	2
Shock	Initial value	100	20	15	
	"Shot at" State	100	0, 2, 4, .., 20	0, 2, 4, .., 16	1-5

Studies - scenarios tested in MANA

- Elementary scenarios based on the Army Tactical Tasks
- Small squads (up to 30)
- Simple behaviour
  - action on contact
  - ambush
  - raid
  - etc

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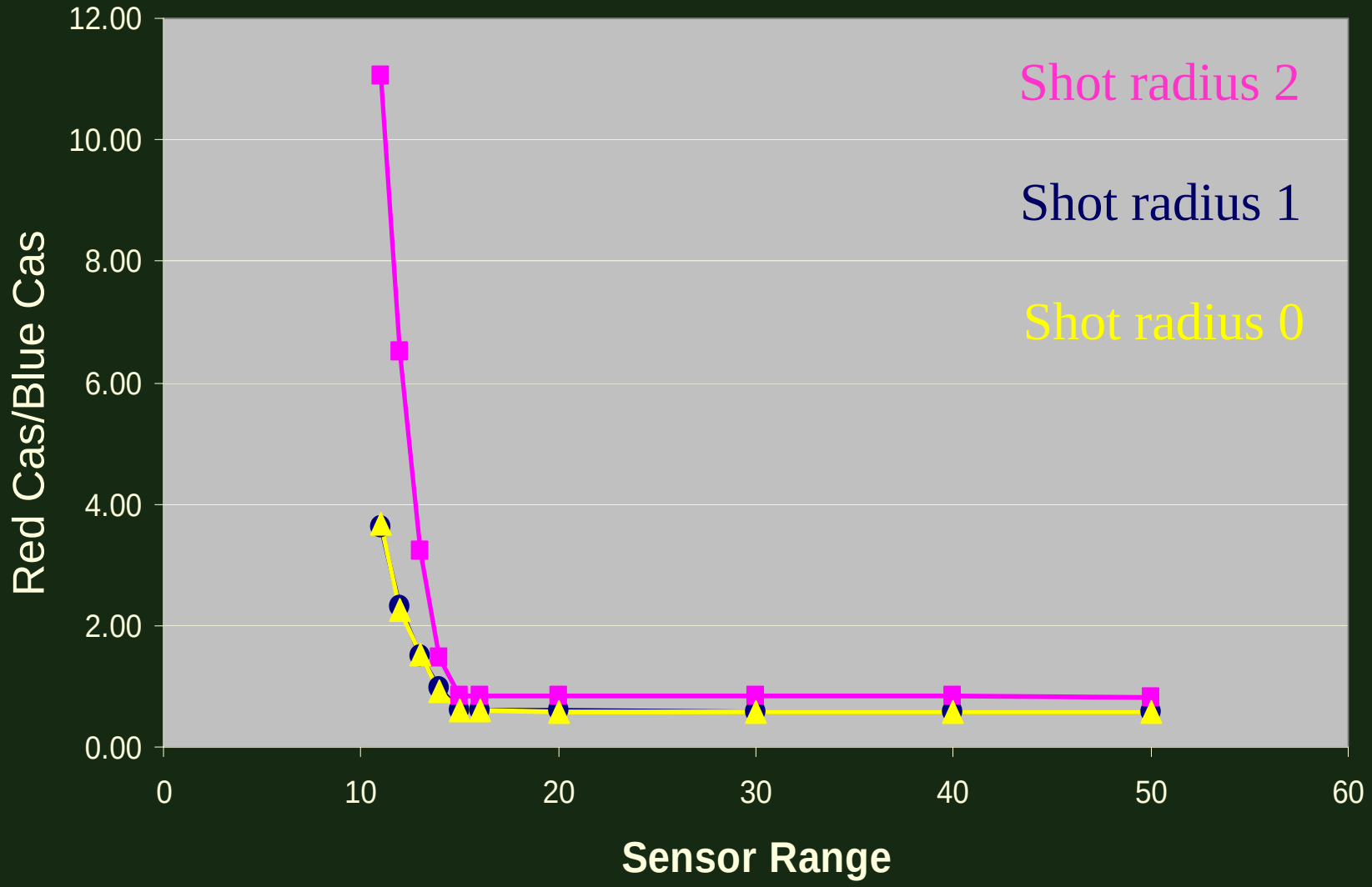
Preliminary results for Surprise



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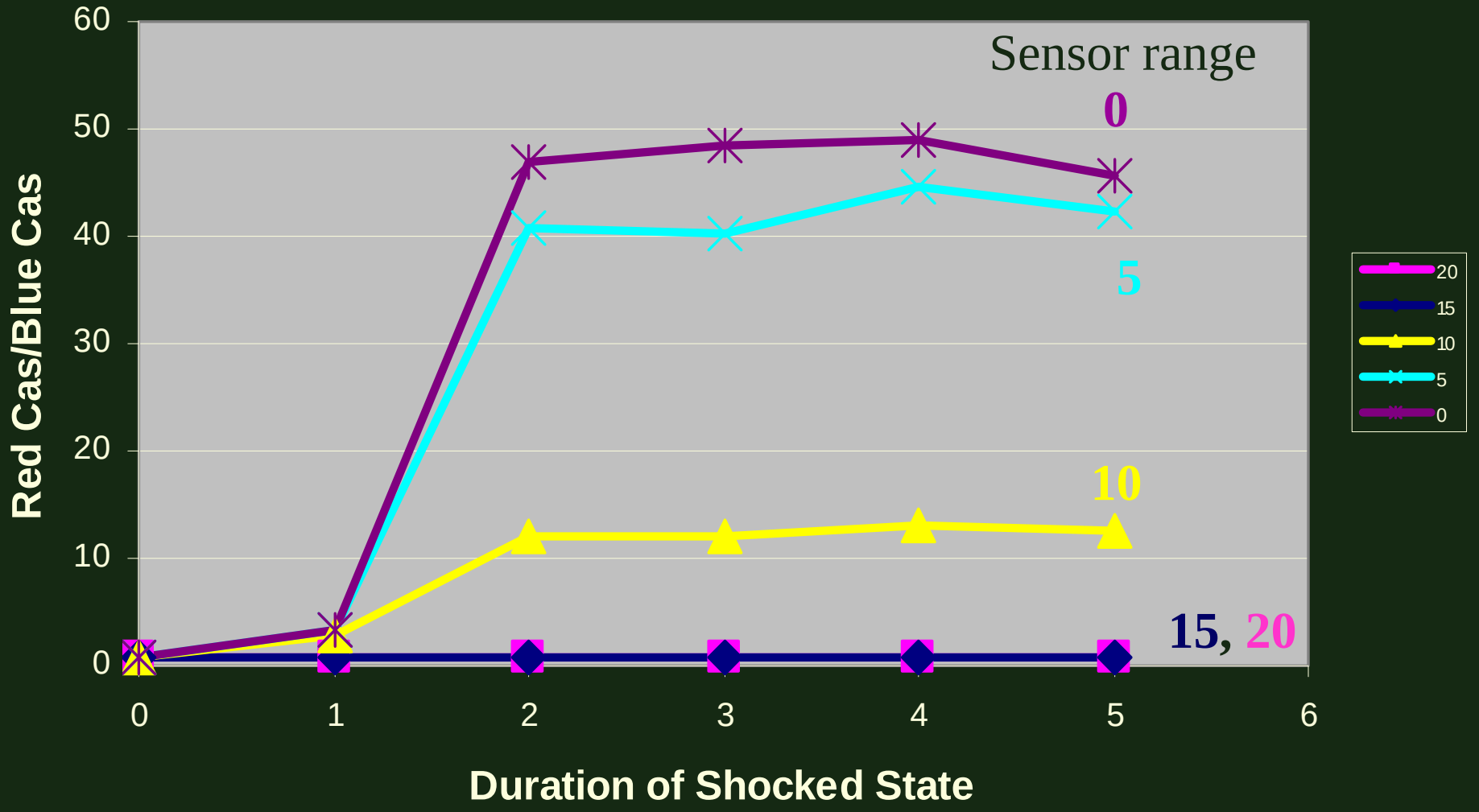
Preliminary results for Shock



Further Work

- Continue with other success factors
- Parametric studies with individual AAAS descriptors
- Ditto with combinations (play off to find “best”)
- Tactics
- Develop new concepts based on tactics and combinations of AAAS descriptors
  - Eg E_3 I_3 C_1 P_1 M_3 S_1 D_2 (highly mobile lethal strike but not sustainable)